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(19)

(54) IMPROVEMENTS IN OR RELATING TO SEALING ASSEMBLIES

(71) We, DECCA LIMITED, a British Company, of Decca House, 9 Albert Embankment, London, SE1 7SW, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a sealing assembly, and in particular to a sealing assembly for use between two regions containing working fluids at different pressures.

According to the present invention, there is provided a sealing assembly for use between a region at high vacuum and a region containing a fluid at a working pressure, comprising a rotar shaft, a sealing element encircling the shaft, a first seal including a helical passageway which is defined between the sealing element and the shaft, a second seal comprising a lip seal encircling the shaft and spaced along the axis of the shaft from the first seal on the side thereof remote from the side of the assembly which is arranged to be adjacent the region of high vacuum, a third seal comprising another lip seal encircling the shaft between said first and second seals, means for applying sealing fluid to the shaft between the second and third seals, a housing which holds the sealing element and the seals, the shaft protruding through a bore in the housing, and a chamber for collecting any leakage of sealing fluid when the shaft is stationary, the chamber being located in the housing adjacent the sealing element on the side of the assembly which is arranged to be adjacent the region of high vacuum.

Reference will hereinafter be made to the accompanying drawing which illustrates schematically one embodiment of the invention.

By way of example, a sealing assembly for a rotor housing having air at atmospheric pressure or above and containing a motor driving a shaft which extends into a region of high vacuum will be described. In this example, the shaft is considerd to rotate in only one direction.

A shaft 1 is driven by a motor (not shown) contained within an enclosed region 2, having air at a pressure P_1. The air is present either for cooling purposes or as a result of air bearing exhaust flow. The shaft is arranged to rotate in a second region 3 which is at a high vacuum. A sealing ring or collar 33 surrounds the shaft with a slight clearance. The sealing ring 33 is fitted within a housing 32 which might either form part of the rotor housing, or be adapted to mate with a suitable bore on the rotor housing, using conventional sealing means.

Two lip seals 30 and 31 are located within the housing 32, below the sealing ring or collar 33 which surrounds the shaft 1. A helical groove 34 is provided in the inside surface of the sealing ring 33 for inducing a flow of sealing fluid towards the lip seals 30 and 31 when the shaft 1 is rotating. The arrangement of the helical groove may be determined by considering standard flow equations which when correctly related enable determination of optimized dimensions for given physical boundary conditions. The lip seals 30 and 31 are separated by a spacer ring 35, which is provided with a radial passage 36 in communication with a passageway 37 in the housing 32. The passageway 37 is connected to a source of sealing fluid (not shown) which may be a reservoir. This arrangement allows sealing fluid which may be, for example, high vacuum diffusion pump oil, to be introduced between the helical groove 34 and the lower lip seal 30, below the upper lip seal 31.

Under normal circumstances, the sealing

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fluid in the source is kept at a pressure which is substantially equal to P_1, the pressure in space 2. Thus, under normal conditions, whether the shaft is rotating or not, the lower lip seal 30 is not subjected to a differential pressure applied across it, and therefore acts to prevent sealing fluid entering the space 2. If in an emergency condition the upper seal 31 fails for any reason, when the shaft is stationary, thus lowering the pressure above lip seal 30, the lip seal 30 acts as a directional seal to prevent the fluid i.e. air in space 2 leaking into space 3. The upper seal 31, normally impedes any flow of sealing fluid upwards through the helical groove 34 when the shaft is stationary. However, since perfect sealing is not always possible, any leakage of sealing fluid that does occur due to the pressure differences across lip seal 31 and groove 34, tends to collect in a space 38 above the sealing ring 33. This accumulation of sealing fluid is pumped downward again by the helical groove 34 towards the lip seals 30 and 31 once the shaft is again rotated. The sealing fluid may return to the source either by passing downward past the lip seal 31, or by a separate passageway (not shown) which may be provided in the housing for this purpose. Generally, some sealing fluid remains in the helical groove 34 due to the pressure difference across it since the downward flow of fluid halts when the induced pressure from the pumping action equals the static pressure difference across the helical groove.

A cover 39 is located above the upper space 38 to hold sealing fluid within the space 38 so that the assembly can be inverted, if necessary, for a short period of time without harm. The cover 39 is provided with an additional part 40 to trap any sealing fluid which may creep up the shaft under surface tension forces. A "thrower" 41 may also be included to throw the sealing fluid into the part 40 when the shaft rotates, from whence it can return to the space 38 via a vent 42 in the cover 39.

This sealing assembly has the advantages that any leakage into the vacuum region is solely as a result of the vapour pressure of the sealing fluid, and no coulomb friction is applied to the shaft. The slight viscous friction which occurs is usually negligible.

WHAT WE CLAIM IS:—

1. A sealing assembly for use between a region at high vacuum and a region containing a fluid at a working pressure, comprising a rotary shaft, a sealing element encircling the shaft, a first seal including a helical passageway which is defined between the sealing element and the shaft, a second seal comprising a lip seal encircling the shaft and spaced along the axis of the shaft from the first seal on the side thereof remote from the side of the assembly which is arranged to be adjacent the region of high vacuum, a third seal comprising another lip seal encircling the shaft between said first and second seals, means for applying sealing fluid to the shaft between the second and third seals, a housing which holds the sealing element and the seals, the shaft protruding through a bore in the housing, and a chamber for collecting any leakage of sealing fluid when the shaft is stationary, the chamber being located in the housing adjacent the sealing element on the side of the assembly which is arranged to be adjacent the region of high vacuum.

2. A sealing assembly as claimed in claim 1, in which the sealing element has a helical groove, constituting the helical passageway, in the surface thereof which encircles the shaft.

3. A sealing assembly as claimed in claim 1 or claim 2, in which the means for applying sealing fluid to the shaft includes passageways formed in the housing which lead to the bore.

4. A sealing assembly substantially as hereinbefore described with reference to and as illustrated in the accompanying drawing.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*